Daily negative affect and smoking after a self-set quit attempt: The role of dyadic invisible social support in a daily diary study

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Abstract: OBJECTIVES Social support receipt from one's partner is assumed to be beneficial for successful smoking cessation. However, support receipt can have costs. Recent research suggests that the most effective support is unnoticed by the receiver (i.e., invisible). Therefore, this study examined the association between everyday levels of dyadic invisible emotional and instrumental support, daily negative affect, and daily smoking after a self-set quit attempt in smoker-non-smoker couples. METHODS Overall, 100 smokers (72.0% men, mean age M = 40.48, SD = 9.82) and their non-smoking partners completed electronic diaries from a self-set quit date on for 22 consecutive days, reporting daily invisible emotional and instrumental social support, daily negative affect, and daily smoking. RESULTS Same-day multilevel analyses showed that at the between-person level, higher individual mean levels of invisible emotional and instrumental support were associated with less daily negative affect. In contrast to our assumption, more receipt of invisible emotional and instrumental support was related to more daily cigarettes smoked. CONCLUSIONS The findings are in line with previous results, indicating invisible support to have beneficial relations with affect. However, results emphasize the need for further prospective daily diary approaches for understanding the dynamics of invisible support on smoking cessation. Statement of contribution What is already known on this subject? Social support receipt from a close other has proven to have emotional costs. According to current studies, the most effective social support is unnoticed by the receiver (i.e., invisible). There is empirical evidence for beneficial effects of invisible social support on affective well-being. What does this study add? Confirming benefits of invisible social support for negative affect in a health behaviour change setting Providing first evidence for detrimental effects of invisible social support on smoking.

DOI: https://doi.org/10.1111/bjhp.12135

Daily Negative Affect and Smoking after a Self-Set Quit Attempt: The Role of Dyadic Invisible Social Support in a Daily Diary Study

Janina Lüscher[1], Gertraud Stadler[2], Sibylle Ochsner[3], Pamela Rackow[3], Nina Knoll[4], Rainer Hornung[3] and Urte Scholz[3]

[1]University of Bern, Switzerland

[2]Columbia University, USA

[3]University of Zurich, Switzerland

[4]Freie Universität Berlin, Germany

*Requests for reprints should be addressed to Janina Lüscher, Fabrikstrasse 8, 3012 Bern, Switzerland (e-mail: janina.luescher@psy.unibe.ch).

*Acknowledgements: The first author is funded by the Swiss National Science Foundation (PP00P1_133632 / 1). This project was funded by the Swiss National Science Foundation (100014_124516).

Received date: June 3, 2014
Accepted date: December 16, 2014

This article has been accepted for publication and undergone full peer-review, but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as DOI: 10.1111/bjhp.12135

Abstract

Objectives: Social support receipt from one's partner is assumed to be beneficial for successful smoking cessation. However, support receipt can have costs. Recent research suggests that the most effective support is unnoticed by the receiver (i.e., invisible). Therefore, this study examined the association between everyday levels of dyadic invisible emotional and instrumental support, daily negative affect, and daily smoking after a self-set quit attempt in smoker-non-smoker couples. ***Methods:*** Overall, 100 smokers (72.0% men, mean age $M = 40.48$, $SD = 9.82$) and their non-smoking partners completed electronic diaries from a self-set quit date on for 22 consecutive days, reporting daily invisible emotional and instrumental social support, daily negative affect and daily smoking. ***Results:*** Same-day multilevel analyses showed that at the between-person level higher individual mean levels of invisible emotional and instrumental support were associated with less daily negative affect. In contrast to our assumption, more receipt of invisible emotional and instrumental support was related to more daily cigarettes smoked. ***Conclusions:*** The findings are in line with previous results, indicating invisible support to have beneficial relations with affect. However, results emphasize the need for further prospective daily diary approaches for understanding the dynamics of invisible support on smoking cessation.

Keywords: invisible social support, negative affect, smoking, inter- and intrapersonal analyses

Daily Negative Affect and Smoking after a Self-Set Quit Attempt: The Role of Invisible Social Support in a Daily Diary Study

Smoking is related to higher risks for serious diseases and is expected to kill more than five million people every year (WHO, 2009). Although smoking rates have been decreasing in the past years, in Switzerland 26% of the adult population are still smokers (Gmel et al., 2013). However, approximately half of all Swiss smokers (48%) want to quit and 20% have seriously tried within the previous 12 months (Keller, Radtke, Krebs, & Hornung, 2011). Smoking remains difficult to conquer as evidenced by low rates of long-term success (Hughes, Keely, & Naud, 2004). Especially, highly addicted smokers have problems with quitting (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Therefore, it is of high importance to examine factors that contribute to successful smoking cessation. One factor assumed to be beneficial for improving cessation rates is social support. Evidence comes from studies that have assessed support receipt from one's partner in the context of smoking cessation (e.g., Carlson et al., 2002; Lawhon et al., 2009).

Social Support

Social support refers to provision of resources intended to benefit the receiver's ability to cope in times of need (Cohen, Gottlieb, & Underwood, 2000). We can distinguish between received (i.e., retrospective reports of actual support from close others) and provided support (i.e., partner perspective) (Schwarzer & Knoll, 2010). These two perspectives do not necessarily closely correspond (Dunkel-Schetter, Blasband, Feinstein, & Bennett, 1992). Few studies so far have taken the perspective of both receiver and provider into account together. Additionally, there are several types of support that can be distinguished, such as emotional (e.g., give reassurance), informational (e.g., give advice), and instrumental (e.g., assist with a problem) (Schwarzer & Knoll, 2010). Discrimination between several types of support provides a basis for determining whether the effectiveness of different types of support differ by kinds of stressful events or by characteristics of persons' distress (Cohen et al., 2000). In

this study we focused on emotional and instrumental support, each of which may yield benefits when provided invisibly (Bolger & Amarel, 2007; Howland & Simpson, 2010).

Invisible Support and its Effects on Affect

Although support is usually thought of a positive thing, some studies showed that support receipt in times of stress appeared to be ineffective or even counterproductive (Maisel & Gable, 2009; Seidman, Shrout, & Bolger, 2006). Different explanations for negative effects of received support exist. One possible explanation is that well-intended attempts of giving support may be mistaken and consequently fail to have the intended effects (Bolger, Zuckerman, & Kessler, 2000; Gleason, Iida, Shrout, & Bolger, 2008; Shrout, Herman, & Bolger, 2006). Another explanation is that receiving support may point to deficits in the recipient and thus can be detrimental for self-esteem and well-being (Bolger et al., 2000; Maisel & Gable, 2009; Shrout et al., 2006). Moreover, in line with equity theory (Adams, 1965), receiving more support than giving also seems to be associated with less well-being (Gleason et al., 2008; Väänänen et al., 2005). Thus, receiving support seems most beneficial if the support is not noticed by the receiver (Bolger et al., 2000). Bolger and colleagues (2000) suggested that *invisible support* (i.e., support providers reported enacting, but recipients did not report receiving) may minimize these harmful effects of received support for well-being. As opposed to invisible support there is also *imagined support* (i.e. support providers did not enact, but receivers reported receiving). Although imagined support is as intriguing as the phenomenon of invisible support, in this study the focus was exclusively on invisible support in order to expand recent findings on invisible support on well-being by also examining effects on health behavior.

Support is invisible when the supportive act occurs outside of the recipient's awareness (Bolger et al., 2000). Such invisible supportive attempts could buffer self-esteem costs of receiving help (Bolger et al., 2000; Maisel & Gable, 2009). Evidence for beneficial effects of invisible support comes from daily diary studies (Bolger et al., 2000; Maisel & Gable, 2009;

Shrout et al., 2006) and experimental studies (Bolger & Amarel, 2007; Howland & Simpson, 2010). For example, Bolger and Amarel (2007) conducted experiments in which participants were led to expect a stressful speech task and peer provided support. Persons who received invisible support showed lower negative affect than persons who received none or visible support. So far, previous research on invisible support focused on outcomes such as stress, well-being, or anxiety. What has not yet been addressed are potential beneficial effects of invisible support on health behaviors, like smoking.

Social Support and its Effects on Smoking Cessation

Several studies showed that support is helpful in smoking cessation (e.g., Carlson et al., 2002; Lawhon et al., 2009). Adding support to a smoking cessation program was effective in improving cessation rates (Carlson et al., 2002). Lawhon and colleagues (2009) found that abstinence-specific support was an important factor in quitting. However, most studies that examined the association between support and smoking cessation investigated only support receipt of smokers without considering the perspective of partner's provided support.

Furthermore, many studies found support unrelated with smoking cessation (Park, Tudiver, & Campbell, 2012; Westmaas, Bontemps-Jones, & Bauer, 2010). Johansson, Johnson and Hall (1991) even found that support at work slightly increased the risk for smoking behavior. A possible explanation for this negative effect could be that smokers receiving support get reminded of smoking all the time. Therefore, *invisible* support could be helpful in reducing smoking without having costs compared to visible support.

To date, there is no study focussing on invisible support and smoking together. Therefore, we investigated the phenomenon of invisible support in the context of smoking cessation with a dyadic design including smokers and their non-smoking partners.

Aim of the Present Study

The aim was to examine the association of dyadic invisible support with daily negative affect and daily smoking after a self-set quit attempt in smokers and their non-smoking

partners. To date, studies on invisible support focused only on stress-related outcomes and did not address health behaviors. Moreover, there are no studies on correlates of invisible support in the context of smoking cessation which can be considered a stressful event for smokers. Here, we wanted to extend previous findings (Bolger & Amarel, 2007; Bolger et al., 2000; Shrout et al., 2006) referring to dyadic invisible support for daily smoking after a self-set quit date. Specifically, we hypothesized, based on the reviewed theoretical models (Bolger et al., 2000; Shrout et al., 2006) that dyadic invisible support will contribute to less negative affect and to fewer cigarettes smoked.

Method

Design and Participants

This study was part of a larger project called DIRECT funded by the Swiss National Science Foundation (100014_124516). For more details please see Ochsner and colleagues (2014)[1].

Couples were recruited via newspapers, web pages, and a marketing research institution. All participants had to be at least 18 years old and fluent in German. Eligible smokers had to be smoking at least one cigarette per day (WHO, 1998) and were required to want to quit. Additionally, they had to be in a committed relationship or married to a non-smoking partner for at least one year and cohabiting with the partner for at least six months. The non-smoking partners had to be never-smokers or non-smokers for at least five years. Potential participants were excluded if they were shift-workers, enrolled in a formal smoking cessation program, or pregnant.

The study had a prospective longitudinal design with daily diary assessments during 32 consecutive days. Couples were invited to the lab for baseline assessment. Smokers were instructed to choose a quit date. Each partner received a smartphone to fill out the diary. Couples were instructed to fill out the daily surveys each night within one hour of going to bed separately from each other, starting ten days before smokers' self-set quit date and 21

days afterwards. The present analyses focused on the quit date itself and the 21 days thereafter in order to capture effects of invisible support during the actual quit attempt. We assumed that invisible support processes would become important after the quit date, when smokers had to refrain from smoking.

After the diary assessment, couples returned to the lab for a follow-up and completed biochemical verification of smoking status with a carbon monoxide test of expired air (West, Hajek, Stead, & Stapleton, 2005). Couples received 200 Swiss Francs for full participation. All couples were treated in accordance to the ethical guidelines of the Helsinki Declaration 2000.

Sample Characteristics

106 smokers and their non-smoking partners participated in the baseline assessment. Six smokers already dropped out before their self-set quit date. As these were not part of the study's population of quitters, they and their partners were excluded. Of the remaining 100 couples, the majority was married (66%) and about half had children (58%). In line with higher prevalence rates of smoking in men, more male smokers participated (72%). Smokers ranged widely in age (M = 40.48, SD = 9.82, range = 19 to 72 years) and education (70% reported to have attended nine years of school and 27% had higher education). Overall, the participating couples showed very high diary completion rates (n = 1979 (90.0%) of 2200). Smokers did not smoke on 45.7% days of the daily dairy phase.

Measures

Table 1 gives an overview on means, standard deviations, and ranges of all measures over the 22 diary days.

Smoker's received support was assessed in line with prior studies (Bolger et al., 2000) with the following instruction: "Support can be emotional (e.g., listening, comforting) or can include practical help (e.g., doing something to help the other person like doing chores)". Then smokers rated emotional support with the item: "Today, I received emotional support

from my partner", and instrumental support with the item "Today, I received practical support from my partner", both on the same scale from 1 "definitely not true" to 6 "completely true".

Partner's provided support contained one item each for emotional and instrumental support reflecting the same content as items for smokers' received support (Bolger et al., 2000). First, the very same explanation was displayed on the smartphone. Then, the non-smoking partners rated the item "Today, I provided emotional support to my partner" for emotional support, and "Today, I provided practical support to my partner" for instrumental social support, on a scale from 1 "definitely not true" to 6 "completely true".

Invisible support was calculated of a score representing smoker-received and partner-provided support to account for both partner's perspectives (Kenny, Kashy, & Cook, 2006). As suggested by Biehle and Mickelson (2012), invisible support was calculated by subtracting received support reported by the smokers from provided support reported by the non-smoking partners. Positive values indicated that more support was provided than received (i.e. invisible social support). Because we were interested in invisible support, we collapsed instances where the recipient reported receiving more than the provider reported giving to zero which is in line with the operationalization of Biehle and Mickelson (2012). Additionally, couples' *average level of support* was calculated as sum of received and provided support divided by two and included as control variable in the analyses to account for differences and extreme values in partner's reported support levels (Kenny et al., 2006).

Smoker's negative affect was assessed by using the short form of the Positive and Negative Affect Schedule (Mackinnon et al., 1999). Negative affect contained five items. Smokers were asked to rate their mood during the day such as "Today I feel distressed" on a scale from 1 "today not at all true" to 6 "today extremely true".

Daily smoking was assessed by two questions. First, smokers were asked "Did you smoke today (including only one puff)?" Response format was no (0) or yes (1). If the response was

yes, they were asked to report the number of cigarettes smoked today. If smokers had not smoked, number of cigarettes smoked was set to 0.

Smoking abstinence was measured at the follow-up with biochemical verification of point prevalence using a Smokerlyzer carbon monoxide test of expired air (Bedfont Instruments, Harrietsham, UK). Smoking participants were categorized as non-smoking with < 9 ppm (parts per million) versus smoking > 9 ppm, following recommendations by West and colleagues (2005).

Nicotine dependence was assessed with the Fagerström-Test of Nicotine Dependence (Heatherton et al., 1991) at baseline. This validated test assesses nicotine dependence with six items, such as, "Do you smoke even if you are so ill that you are in bed most of the day?" Scores of the items were summed up, whereas higher scores indicated higher levels of nicotine dependence. A positive correlation between nicotine dependence and number of cigarettes smoked occurred, indicating that nicotine dependence is related to higher number of cigarettes smoked. Therefore, the Fagerström-Tests of nicotine dependence was used as a covariate in our analyses with daily smoking.

(Table 1)

Data Analysis

The focus of this study was to examine whether invisible support predicted daily negative affect and daily smoking at the between-person and the within-person level. In accordance with Cranford and colleagues (2006) reliabilities for between-person differences and within-person change in negative affect over the 22 diary days were computed. The between-person reliability R_{KF} indicates how reliable between-person differences are assessed with a scale for all items averaged over all days whereas the within-person change R_C indicates the reliability of measuring systematic change of persons over the 22 diary days (Cranford et al., 2006). We also computed intra-class correlations (ICCs). The intra-class correlation is defined as amount

of variance between second level units, in this case individuals, in relation to total variance (Kreft & DeLeeuw, 1998).

As the present study comprised intensive longitudinal data, multilevel linear models were employed in SPSS 21 to account for the hierarchical data structure (Bolger & Laurenceau, 2013). Multilevel modelling allows investigating associations between predictors and outcome variables at both the within-person (Level 1) and the between-person level (Level 2) (Bolger & Laurenceau, 2013). Because support is supposed to have rather short-term effects (Shrout et al., 2010) and the relation between invisible support and smoking was examined for the first time we conducted same-day analyses to establish same-day associations before analysing temporal order of associations.

For analyzing *daily negative affect* we used a linear mixed model to account for autocorrelation following recommendations by Bolger and Laurenceau (2013). For analyzing the count variable *daily number of cigarettes smoked* we used a generalized linear mixed Poisson model with a logarithmic link function. Poisson regression is appropriate for count data with skewness and zeros and connects predictors via a natural logarithm link function to dependent variables (Atkins et al., 2013; Xie, Tao, McHugo, & Drake, 2013). That is why the regression coefficients of a Poisson model are exponentiated and described as rate ratios. In rate ratios the distance above and below one indicates for the percentage increase or decrease in the dependent variable for a one-unit increase in the predictor (Atkins et al., 2013).

To model systematic effects over time, a time variable for the 22 investigated diary days (centered on quit date = 0) was computed. To examine invisible support at the between-person and within-person level, all predictors were centered. We calculated person means for all predictors over the 22 diary days and centered person means around the grand mean in the sample (between-person level) (Bolger & Laurenceau, 2013). Additionally, we modelled daily fluctuations around person means by centering person-specific daily scores around the person-specific mean (within-person level) (Bolger & Laurenceau, 2013). Also, nicotine dependence,

a continuous covariate at Level 2, was centered around the grand-mean. We composed an inter-correlation among daily smoking, and nicotine dependence at the between-person level. To calculate the average between-person correlation, a Pearson correlation of the individual mean levels was conducted.

Finally, each regression model contained the following predictors: The linear *time* variable, the within-person level of invisible support and within-person average couple level of support at level 1, as well as between-person level of invisible support and between-person average couple level of support as covariate at level 2. Additionally, based on significant bivariate associations with daily smoking, *nicotine dependence* was included as covariate at level 2. Furthermore, a maximal random effects structure was specified for each model (Barr, Levy, Scheepers, & Tily, 2013) including random slopes of all Level 1 predictors (allowing individuals to differ in associations between predictor and outcome). In case of nonconvergence, the random effects structure was progressively simplified until convergence was reached[2].

Results

Preliminary Analysis

The negative affect scale showed acceptable reliabilities (Kline, 2000). Between-person reliability was $R_{KF} = 0.99$ and within-person reliability was $R_C = 0.79$. Intra-class correlations revealed moderate ICCs varying from 0.36 to 0.84 (see Table 1). An ICC of 0.36 for *provided emotional support* indicated that slightly more than a third of the variation was attributable to stable between-person differences. An ICC of 0.84 for *daily number of cigarettes smoked* indicated that slightly more than 80 percent of the variation was attributable to stable between-person differences.

The carbon monoxide test of expired air resulted in 67 non-smoking participants. Those biochemically verified non-smoking participants included all of the 34 participants that

reported in the questionnaire that they had not smoked since their quit date (Ochsner et al., 2014; West et al., 2005).

Invisible Support as Predictor of Smokers' Daily Negative Affect

Results for the linear mixed model testing invisible emotional and instrumental support as predictors for daily negative affect are displayed in Table 2. The intercept indicates the estimated negative affect for the quit day (coded 0) for the average person (e.g. when all covariates are equal to zero) and it was $b = 2.24$ for the model testing invisible emotional support as predictor and $b = 2.23$ for the model testing instrumental support as predictor. A significant negative effect emerged for time. This indicates that daily negative affect decreased over the 22 diary days.

At the between-level, a significant negative effect for invisible emotional and instrumental support on negative affect emerged (see Figure 1). Results indicate that higher individual mean levels of invisible emotional and instrumental support across the 22 diary days were associated with less daily negative affect. Additionally, there was a significant positive effect for the average couple level of emotional and instrumental support, indicating that higher average couple level of emotional and instrumental support across the 22 diary days were associated with more negative affect.

At the within-level, no significant effects for invisible emotional and instrumental support emerged. Yet, a significant negative effect for average couple level of emotional support emerged at the within-level, indicating that on days with higher than usual couple's reports of emotional support, less negative affect was experienced.

The level-2 random effects of the intercept and time slope were significantly different from zero for both models with daily negative affect. Results indicated that smokers differed in their initial negative affect on the quit date and in their slope over time, and that smokers starting with higher negative affect showed smaller time slopes. Level-1 random effects gave

evidence for residual variance, representing the deviations of daily scores of negative affect from predicted values in the two models, and for autocorrelations of residuals.

(Table 2) #, # (Figure 1)

Invisible Support as Predictor of Smokers' Daily Smoking

Results of the generalized linear mixed Poisson model testing invisible emotional and instrumental social support as predictors for daily smoking are shown in Table 3. The rate ratio of the intercept describes the estimated number of cigarettes smoked on the quit date (coded 0) when all covariates are equal to zero for the average person and was RR = 3.61 for invisible emotional support and RR = 3.45 for invisible instrumental support. A marginal significant negative effect emerged for time in the model with invisible emotional support as predictor: the RR of 0.98 indicating that number of cigarettes smoked decreased by 2% over the 22 diary days. A significant positive effect emerged for nicotine dependence in the models testing invisible emotional and instrumental support as predictors.

On the between-level, a significant positive effect for invisible emotional and instrumental support emerged (see Figure 2). These results indicated that higher individual mean levels of invisible emotional and instrumental support across the 22 diary days were associated with *more* cigarettes smoked on the same day. The RR's indicated an increase of 31% for invisible emotional support and 29% for invisible instrumental support respectively in number of cigarettes smoked with a one-unit increase in invisible support. Additionally, there was a significant negative effect for the average couple levels of emotional and instrumental support, indicating that higher average couple levels of emotional and instrumental support across the 22 diary days were associated with fewer number of cigarettes smoked.

At the within-level, no significant effects for invisible emotional and instrumental support emerged. Yet, a significant negative effect for the average couple levels of emotional and instrumental support emerged, indicating that on days with higher than usual couple's reports of emotional and instrumental support, less cigarettes were smoked. The RR's indicated a

reduction of 10% for average couple level of emotional support and 7% for average couple level of instrumental support respectively in number of cigarettes smoked with a one-unit increase in means of support.

The level-2 random effect of the time slope was significantly different from zero for the model with invisible emotional support as predictor, indicating that smokers differed in their slope over time and that smokers starting with a higher number of cigarettes smoked showed smaller time slopes. Due to nonconvergence no random effects for time could be computed for the model with invisible instrumental support as predictor. Again, the level-1 random effects gave evidence for residual variance, representing the deviations of daily scores of number of cigarettes smoked from predicted values in the two models, and for autocorrelations of residuals.

(Table 3) #, # (Figure 2)

Discussion

This study investigated associations between dyadic invisible support, daily negative affect, and daily smoking after a self-set quit attempt in smoker-non-smoker couples. Between-person and within-person associations were investigated on a daily basis for 22 consecutive days. Multilevel analyses revealed that higher levels of invisible support were related to less negative affect across the 22 days. These results confirm our hypothesis that invisible support has beneficial effects on well-being and replicate previous findings for a health-behavior change context. On the within-person level, however, there were no significant effects. These different results for the between-person and the within-person level demonstrate the independence of results at the two levels (Bolger & Laurenceau, 2013). Results also provide insights into the dyadic interplay of provided and received support. In terms of operationalizing invisible support, we chose the approach by Biehle and Mickelson (2012) which allowed calculating invisible support out of two continuous variables. In line with Biehle and Mickelson (2012) we chose to set all values to zero that would indicate

"imagined" support, i.e. higher reports of support by the receiver than by the provider. Future research should examine both directions of the continuum of this discrepancy between provided and received support by considering not only invisible but also imagined support. Support visibility is a relatively new research area and examining not only invisible but also imagined support processes would allow expanding the prior literature and deepening our understanding of how different support transactions within couples work with regard to well-being and health behavior.

Moreover, applying a continuous measure of invisible support might also raise the question whether there are different kinds of invisibility. Future research might distinguish between invisible support as support that is truly unnoticed by the receiver from invisible support that is noticed by the recipient but not perceived as helpful. To distinguish between these forms of invisible support satisfaction as a possible mechanism should be taken into account. This might also be fruitful in further examining when invisible support is helpful and when it is not or even rather detrimental as demonstrated in our results for smoking behavior.

Furthermore, our study provides new insights into the effects of invisible support on health behavior. In contrast to the results on affect, our findings indicate less beneficial effects of invisible support for daily smoking. At the between-person level higher mean levels of invisible support were associated with an increase in daily smoking across the 22 days. The current literature indicates that benefits of invisible support may vary by context in which it is provided (Biehle & Mickelson, 2012) and no study so far used the context of smoking cessation. A possible explanation for these negative effects might be that a quitter needs a visible assistance for a smoking cessation attempt. Therefore, it would be important to understand the impact of support visibility of receivers and providers in this specific context. Additionally, further research should focus on mechanisms behind the association of invisible support and smoking. However, higher smoking after a quit attempt may also go along with higher invisible support as an adaptive reaction from the partner. We only focused on same

day associations and therefore, interpretations regarding predictive direction or causality cannot be drawn.

Compared to previous findings of support receipt, invisible support results of the present study go exactly in the opposite direction for affect and smoking. Former studies provided evidence that support receipt from one's partner is helpful in smoking cessation (e.g., Carlson et al., 2002; Lawhon et al., 2009). However, recent findings of diary studies indicate that in times of stress support receipt can increase distress in recipients (e.g., Gleason et al., 2008; Seidman et al., 2006). Received support, hence, can have emotional costs. In the present study, we found evidence for beneficial effects of invisible support on daily negative affect in smokers trying to quit and disadvantageous effects on daily smoking. Therefore, received support and invisible support are both mixed blessings related with different outcomes (Väänänen et al., 2005). Note, however, that received support represents the perspective of only one dyad member, while invisible support is a dyadic phenomenon. Therefore, a comparison between received and invisible support in different studies is difficult and for future studies, dyadic designs are desirable.

This study was the first to investigate invisible support and a health behavior. Overall, the results provide evidence for the usefulness of investigating the role of invisible support for two different outcomes, such as daily negative affect and daily smoking in the context of smoking cessation. Findings emphasize the need for future prospective daily diary approaches to further our understanding in the dynamics of invisible support not only in smoking cessation but also in other health behaviors. Furthermore, future research should consider dyadic approaches and also address well-being of the partners.

Strengths and Limitations

Strengths of the present study are the daily diary and the dyadic design by considering receivers' and providers' perspective of support in smoker-non-smoker couples. Nonetheless, there are several limitations that need to be addressed. First, as most daily dairy studies, we

used single-item measures for received and provided support to reduce time demands. However, single-item measures show comparable validity compared to multi-item measures (Bergkvist & Rossiter, 2007). Second, all variables are based on self-report. According to Shiffman (2009) self-reported data can be memory- and recall-biased. Due to the daily diary design, however, retrospection errors could be minimized (Bolger, Davis, & Rafaeli, 2003). According to Velicer, Prochaska, Rossi, and Snow (1992) self-reports of smoking are valid indicators. Furthermore, point prevalence of non-smoking was biochemically verified with a carbon monoxide test of expired air (West et al., 2005). All 34 participants reporting continuous abstinence during the diary phase were also biochemically identified as current non-smokers. Therefore, the self-report measure of number of cigarettes smoked seems to be a valid assessment. Third, support measures were not assessed smoking-specific. We assessed support generally in line with Bolger and colleagues (2000) in order to transfer their effects of invisible support on well-being to the context of smoking cessation. Future studies might compare effects of smoking-specific and general support on affect and smoking in order to examine whether effects also depend on the different measures of support (see a recent study of Bock and colleagues (2013) on this comparison who did not find different results). Fourth, this study did not distinguish between smokers who successfully quit and smokers who lapsed or relapsed after the quit attempt. Future research should account for this issue by considering smoking status as a moderator of the relation between invisible support and affect.

Fifth, we tested same-day associations and did not test any cross-lagged effects. Cross-lagged effects help to establish the temporal order of associations (Stadler, Snyder, Horn, Shrout, & Bolger, 2012). Support provided has been proposed to have short-term rather than longer-term effects on smoking cessation (Mermelstein et al., 1996) and also on negative affect (Shrout et al., 2010). Therefore, in line with assumptions on short-term-effects of support, we first wanted to establish same-day associations before analyzing temporal order of associations. Finally, further research with daily-life interventions, called ecological

momentary interventions (EMI; Heron & Smyth, 2010) will be needed to explore causality. Health behavior change can be extended beyond traditional research by using mobile technology to deliver interventions to people as they go about their daily lives and provide insight into temporal relationships among variables (Heron & Smyth, 2010; Smyth & Stone, 2003). For the context of smoking cessation, for example, a text message delivering visibility of support interventions could be developed by having partners provide help to smokers in one of different ways.

Despite these limitations, the present study yielded evidence that dyadic invisible support is not only associated with well-being but also with daily smoking albeit in an unexpected direction.

Conclusions

Findings of the present study raise several important issues for future research. In particular, invisible support may serve as a protective buffer for affective well-being in times of stress as evidenced before. Furthermore, our data indicated that associations of invisible support and smoking cessation might be rather adverse. Further research should investigate how invisible support can be beneficial for facilitating non-smoking and should also consider well-being of partners. Furthermore, future studies need to establish generalizability of our findings in the context of smoking cessation within smoker-non-smoker couples.

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Footnotes

[1] This study was part of a larger longitudinal study. Based on these data, the research team has pursued other unique theoretical questions in several publications with a different focus and different data subsets, including Ochsner et al. (2014), Lüscher, Ochsner, Berli et al. (2014b), and Lüscher, Ochsner, Knoll et al. (2014a).

[2]Due to the competing statement of repeated measures, models including a random effect of the intercept did not converge. This is why no random intercept was specified in the analyses with daily number of cigarettes smoked as outcome.

Table 1

Available and missing data, means, standard deviations, ranges, and intra-class correlations (ICCs) for main variables

	n	Missing	*M*	*SD*	Range	ICC
Received emotional social support	1979	10.0%	2.39	1.42	1 to 6	0.50
Received instrumental social support	1979	10.0%	2.15	1.30	1 to 6	0.57
Provided emotional social support	1956	11.1%	2.66	1.37	1 to 6	0.36
Provided instrumental social support	1956	11.1%	2.30	1.24	1 to 6	0.46
Invisible emotional social support	1859	15.5%	0.24	1.51	-5 to 5	0.39
Invisible instrumental social support	1859	15.5%	0.12	1.50	-5 to 5	0.47
Number of cigarettes smoked	1979	10.0%	4.63	7.17	0 to 45	0.84
Negative affect	1979	10.0%	2.11	0.89	1 to 6	0.61

Table 2

General Linear Mixed Model of daily negative affect regressed on invisible emotional and instrumental social support

	Invisible emotional social support				Invisible instrumental social support			
			95% CI				95% CI	
Fixed Effects	*b*	*SE*	Lower	Upper	*b*	*SE*	Lower	Upper
Intercept	-2.24***	0.08	-2.09	-2.39	-2.23***	0.07	-2.08	-2.38
Time	-0.01***	0.00	-0.02	-0.01	-0.01***	0.00	-0.02	-0.01
Between-person mean support	-0.20*	0.08	-0.04	-0.36	-0.29**	0.08	-0.13	-0.46
Within-person mean support	-0.04*	0.02	-0.07	-0.01	-0.03	0.02	-0.06	-0.01
Between-person invisible support	-0.39**	0.11	-0.61	-0.17	-0.38***	0.10	-0.58	-0.17
Within-person invisible support	-0.02	0.02	-0.01	-0.04	-0.00	0.02	-0.03	-0.04
			95% CI				95% CI	
Random Effects (variances)	Estimate	*SE*	Lower	Upper	Estimate	*SE*	Lower	Upper
Level 2 (between person)								
Intercept	0.46***	0.80	-0.33	0.65	-0.45***	0.08	-0.32	0.64
Time	0.01**	0.00	-0.00	0.00	-0.00**	0.00	-0.00	0.00
Level 1 (within person)								
Residual	0.28***	0.01	-0.26	0.31	-0.28***	0.01	-0.26	0.31
Autocorrelation	0.30***	0.03	-0.25	0.36	-0.30***	0.03	-0.24	0.36

Note. $N = 99$ couples, 22 days maximum, $n = 1859$ available days. *b* = unstandardized regression coefficients, *SE* = standard errors; 95% CI = 95% confidence intervall ; * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 3

Generalized Linear Mixed Poisson Model of daily smoking regressed on invisible emotional and instrumental social support

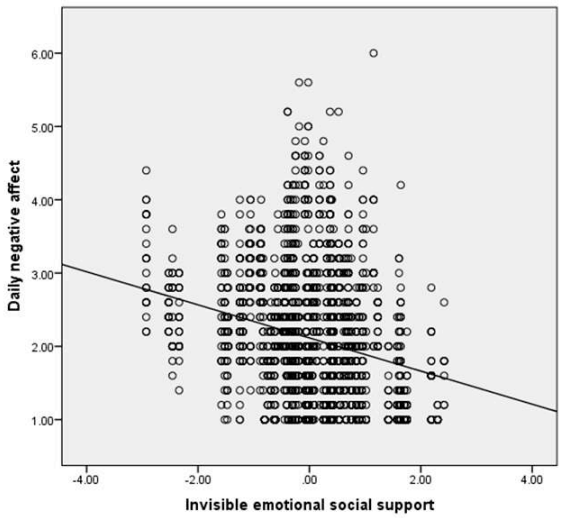
	Invisible emotional social support					Invisible instrumental social support				
				95% CI					95% CI	
Fixed Effects	*b*	*SE*	RR	Lower	Upper	*b*	*SE*	RR	Lower	Upper
Intercept	-1.29***	0.10	3.61	2.98	4.39	-1.24***	0.13	3.45	2.66	4.47
Time	-0.02#	0.01	0.98	0.97	1.00	-0.01	0.01	1.01	0.99	1.02
Nicotine dependence	-0.34***	0.04	1.41	1.31	1.51	-0.37***	0.04	1.44	1.33	1.56
Between-person mean support	-0.59***	0.09	0.56	0.46	0.67	-0.50***	0.12	0.61	0.48	0.77
Within-person mean support	-0.10***	0.02	0.90	0.87	0.94	-0.07**	0.03	0.93	0.89	0.98
Between-person invisible support	-0.27*	0.12	1.31	1.04	1.65	-0.25*	0.13	1.29	1.01	1.64
Within-person invisible support	-0.02	0.02	1.02	0.99	1.06	-0.00	0.02	1.00	0.96	1.04
				95% CI					95% CI	
Random Effects (variances)	Estimate	*SE*	Lower		Upper	Estimate	*SE*	Lower		Upper
Level 2 (between person)										
Time	0.00**	0.00	0.00		0.01	-	-	-		-
Level 1 (within person)										
Residual	4.40***	0.40	3.68		5.26	7.78***	0.53	6.81		8.89
Autocorrelation	0.75***	0.02	0.70		0.79	0.83***	0.01	0.81		0.85

Note. $N = 99$ couples, 22 days maximum, $n = 1859$ available days. *b* = unstandardized regression coefficients, *SE* = standard errors; RR = rate ratios ; 95% CI = 95% confidence intervall; * $p < .05$, ** $p < .01$, *** $p < .001$. Due to nonconvergence no random effect for time could be computed in the analysis of instrumental social support.

Figure captions:

Figure 1: illustrates the distribution of dyadic invisible emotional and instrumental social support and daily negative affect using the raw data and depict a linear regression fit line.

Figure 2: illustrates the distribution of dyadic invisible emotional and instrumental social support and daily number of cigarettes smoked using the raw data and depict a linear regression fit line.


Daily negative affect
6.00
5.00
4.00
3.00
2.00
1.00
-4.00
-2.00
.00
2.00
4.00
Invisible emotional social support

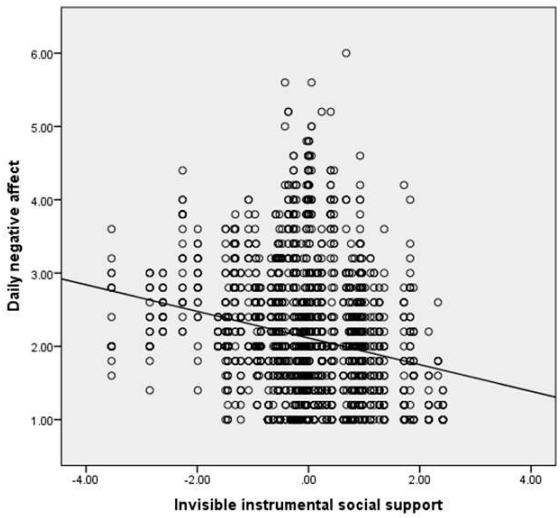

Daily negative affect
6.00
5.00
4.00
3.00
2.00
1.00
-4.00
-2.00
.00
2.00
4.00
Invisible instrumental social support

Figure 1

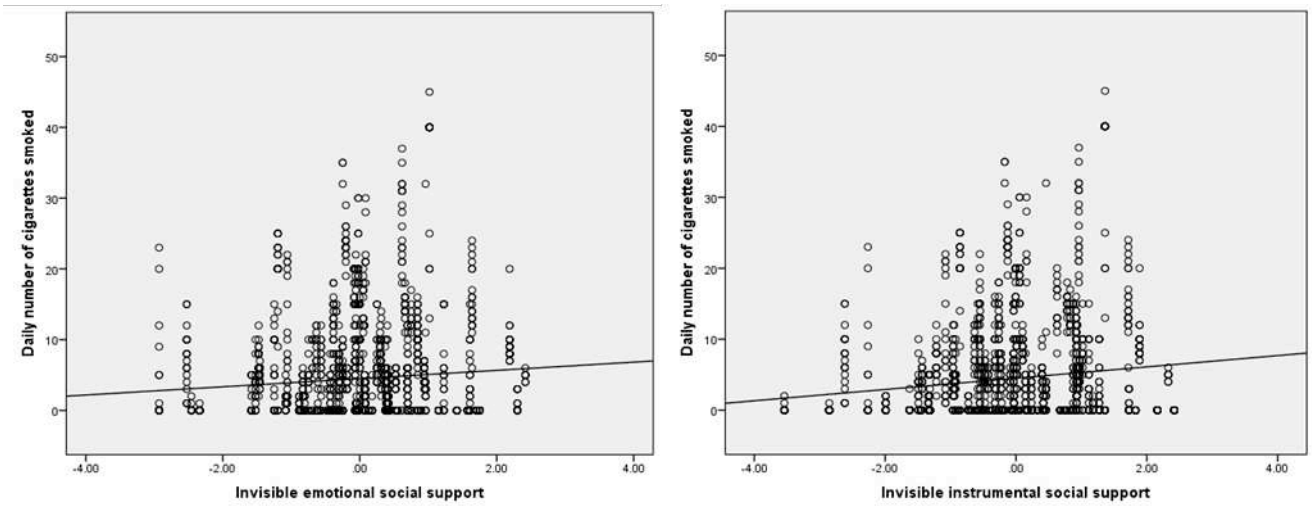

Daily number of cigarettes smoked
50
40
30
20
10
0
-4.00
-2.00
.00
2.00
4.00
Invisible emotional social support
Daily number of cigarettes smoked
50
40
30
20
10
0
-4.00
-2.00
.00
2.00
4.00
Invisible instrumental social support

Figure 2